

# Artificial pancreas: closer to an optimal treatment for diabetes?

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**January 2006**

The development of an artificial pancreas as a potential treatment for patients with diabetes is getting closer to reality. Doctors who have researched the artificial pancreas are optimistic, as the prospect of using it for treatment would be a giant leap forward in the area of diabetes therapy.

Researchers say that in the future, diabetic patients with an artificial pancreas may have a significantly increased ability to monitor their blood glucose levels, eliminate their need for insulin injections and improve their metabolic control.

Although several important obstacles still impede the development of an artificial pancreas, scientists say that after decades of research on this issue, it may soon become a reality.

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## **The system's benefits**

There is great clinical need for a medical device that can automatically control the level of blood/tissue glucose in ambulatory patients with diabetes, by delivering the appropriate dose and timing of insulin in response to meals, exercise, sleep, and illness, according to Jeffrey Joseph, DO, director of the Artificial Pancreas Center at Jefferson Medical College of Thomas Jefferson University in Philadelphia.

Dynamic changes in nutrient intake, hepatic glucose output, and insulin sensitivity require continuous monitoring of glucose levels and rapid adjustments in insulin delivery to minimize postprandial hyperglycemia and prevent hypoglycemia. A secondary goal of the device is to deliver the appropriate dose and timing of insulin to normalize fasting and postprandial lipid profiles to decrease the risk for developing atherosclerosis.



**“Since an artificial pancreas could be used to treat patients with both type 1 diabetes and type 2 diabetes, there is tremendous interest in seeing this succeed.”**

**—Aaron Kowalski, MD**

An artificial pancreas is a mechanical system that integrates one or more real-time glucose sensors, a computer controller, and an insulin delivery system.

Advanced artificial

pancreas systems will automatically deliver glucagon and/or glucose at the appropriate dose and time either routinely following a meal or as a rescue to minimize the risk for hypoglycemia. Future artificial pancreas systems may have physiological sensors that determine the onset of a meal, determine the level and duration of physical activity, and measure the concentration of insulin in blood.

Joseph said the automated system will make the management of blood glucose levels much safer and easier for the ambulatory patient with type 1 and type 2 diabetes. “The key here is the real-time monitoring of glucose levels in contrast to intermittent self-monitoring,” he told *Endocrine Today*.

Patients and their doctors will have significantly more information about their diabetes management with an artificial pancreas. “This allows for 1,440 data points per day,” he said. “Continuous glucose monitoring provides detailed information about the absolute glucose level, the direction of change, and the rate of change. Even patients who regularly self-monitor usually have less than eight measurements per day and often do not know if their blood glucose levels are rising or falling. The artificial pancreas system would improve blood glucose control and decrease the risk for hypoglycemia.”

Stuart Weinzimer, MD, associate professor of pediatrics at Yale University School of Medicine, agreed that the artificial pancreas would be significantly advantageous for patients with diabetes.

“Ideally it would have the potential to normalize the patient’s glucose levels both at night and during the day,” he told *Endocrine Today*. “This would be the first time in history we have had the opportunity to have this. This would be light years ahead of other current treatments.”

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## **Mechanical intervention**

Eventually, doctors envision that all patients with diabetes could be treated with an artificial pancreas. But once the device is viable and approved by the FDA, doctors say many patients could benefit.

“The idea of mechanical intervention helping patients with diabetes control their disease is appealing. Recent studies show patients spending less than a third of the day in euglycemia. This technology could prevent both highs and lows,” Aaron Kowalski, PhD, scientific program manager of the Juvenile Diabetes Research Foundation in New York, told *Endocrine Today*.

“With an artificial pancreas, patients with diabetes would be allowed to have minute-to-minute monitoring of glucose.”  
— *Stuart Weinzimer, MD*

Doctors suggest that the ideal patient initially would be one who is not afraid of new technology and who is already vigilant in managing their diabetes. But eventually, all patients with diabetes could be using an artificial pancreas, as there is probably no patient who would not benefit from one or who could not use one, he said.

“The ultimate goal is to develop an artificial pancreas that could be used by all patients with diabetes,” Joseph said. “To achieve this, we need to make the device very user-friendly.”

### Comparison of insulin delivery systems

Patients and their doctors will have significantly more information about their diabetes management with an artificial pancreas. Future artificial pancreas systems may have physiological sensors that determine the onset of a meal, determine the level and duration of physical activity, and measure the concentration of insulin in blood. Currently the artificial pancreas is being tested on a closed-loop system.

#### **Closed-loop system**

- Subcutaneous sensor determines glucose levels on a continuous basis and transmits data to an insulin pump.
- Computer algorithm contained in pump calculates appropriate rate of insulin delivery and automatically gives small bolus to keep glucose level at defined setpoint.

#### **Prototypic closed-loop system with laptop**

- Sensor signals are transmitted to a laptop computer that displays the sensor glucose and calculates rate of insulin delivery.
- Rate of insulin delivery is transmitted to the insulin pump.

### In development

Researchers have been trying to develop an artificial pancreas since the 1970s. The continuous glucose monitoring system has been the hurdle for most of this time. Now that continuous glucose monitoring systems are being perfected, the artificial pancreas has come closer to actuality.

Despite the optimism, the artificial pancreas remains in the development stage. But as results continue to be promising, increased research and funding have been centered on its development.

“As preliminary results for an artificial pancreas look promising, funding for this research has increased,” Kowalski said. “Private companies, the National Institutes of Health and voluntary organizations like the JDRF are all promoting this research.”

Kowalski added that a thriving market is needed to encourage continuous investment in new generations of technology.

“Ensuring these devices are covered by health insurance will help create a substantial market and ensure widespread patient success,” he said. “Since an artificial pancreas could be used to treat patients with both type 1 diabetes and type 2 diabetes, and this represents a huge population, there is tremendous interest in seeing this succeed.”

Researchers also note that cost should not be a prohibitive concern for the development of an artificial pancreas.

Since an artificial pancreas could offer drastic improvements for a patient’s diabetes management, the risk of long-term health complications would be significantly lower.

“Cost should not be an issue,” Joseph said. “If the artificial pancreas works, it will prevent both short-term and long-term complications and offer an improved lifestyle for the patient.”